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## A NEW SPECIES OF THE GENUS *APATROBUS* HABU ET BABA, 1960 (COLEOPTERA: CARABIDAE: PATROBINI) FROM JAPAN

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**Summary.** *Apatrobis hekosanus* sp. n. is described from Mt. Hekosan, Central Honshu, Japan. This species is readily distinguished from all adjacent congeners by the shape of the pronotum and structure of the male endophallus. The relationships among the new and adjacent related species were inferred from interspecific differences in morphology and habitat altitude, and knowledge of the differentiation process of other congeners.

**Key words:** ground beetles, Patrobinae, taxonomy, new species, morphology, male genitalia, Honshu Island, East Asia.

**К. Сасакава. Новый вид рода *Apatrobis* Habu et Baba, 1960 (Coleoptera: Carabidae: Patrobini) из Японии // Дальневосточный энтомолог. 2020. N 413. С. 1-7.**

**Резюме.** С горы Хекосан в центре о-ва Хонсю (Япония) описан *Apatrobis hekosanus* sp. n. Этот вид хорошо отличается от распространенных поблизости видов этого рода по форме переднеспинки и эндофаллуса. Обсуждаются отношения нового вида и родственных форм и процесс их дифференциации в свете межвидовых различий в морфологии и высоте обитания.

## INTRODUCTION

*Apatrobus* Habu et Baba, 1960 is a Japanese endemic genus of the tribe Patrobini (Carabidae: Patrobinae). Members of the genus occur in mountainous areas and have poor dispersal ability due to atrophied hind wings. Marked geographical differentiation is recognized, and 21 species-group taxa (20 species and one subspecies) have been described (Zamotailov, 2017). A recent molecular phylogenetic study of this genus supported the status of most of the known species and revealed the presence of many undescribed species that have not been distinguished taxonomically (Dejima & Sota, 2017). Some of these undescribed species are geographically close to known species, but have sufficient genetic differences to be considered separate species. Consequently, these findings suggest that *Apatrobus* has diversified in narrower areas than previously recognized, and that it is important to recognize as many geographical variants as possible for future comprehensive studies of this genus.

In the course of my taxonomic revision of *Apatrobus*, I had an opportunity to examine a specimen from a mountain in central Honshu. Detailed examination of the external and genitalia morphology of this specimen revealed its separate species status from known species and its peculiar relationship with related species; the latter, along with results of molecular phylogenetic and morphometric analyses (Dejima & Sota, 2017), gives insights into our understanding of the diversity of *Apatrobus*. Here, this specimen is described as a new species and its peculiar affinity is discussed.

## MATERIAL AND METHODS

The material examined is deposited in the collection of the Laboratory of Zoology, Department of Science Education, Faculty of Education, Chiba University, Chiba, Japan [CHUJ]. The male endophallus was everted by injecting toothpaste from the basal end of the aedeagus. The endophallus structure terminology follows Sasakawa & Toki (2007). Information on four related locally adjacent species, namely *A. echigonus* (Habu et Baba, 1962), *A. hasemiya* Morita, 1990, *A. iwasakii* Morita, 1987, and *A. narukawai* Morita, 1989, was obtained from their original descriptions (Habu & Baba, 1962; Morita, 1987, 1989, 1990), which describe all key morphological characters and morphometric values of the species in detail and are available for comparative studies. For *A. echigonus*, information was also obtained from photographs of the holotype, which are available in the type-specimen database of the National Agriculture and Food Research Organization (Division of Informatics and Inventory, Insect Systematics Unit, Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, 2011).

The following abbreviations are used: BLc – body length from clypeal apex to elytral end; BLl – body length from anterior margin of labrum to elytral end; BLm – body length from the mandible apices to elytral end; EL – elytral length along the

midline; EW – elytral width at widest part; HW – head width at widest part; PA – pronotal anterior margin width; PB – pronotal posterior margin width; PL – pronotum length along median line; PW – pronotum width at widest part.

## TAXONOMY

### Family Carabidae

#### Genus *Apatrobus* Habu et Baba, 1960

##### *Apatrobus hekosanus* Sasakawa, sp. n.

<http://zoobank.org/NomenclaturalActs/6BCCCA09-D865-48C2-BEA3-8B5E4D19A4BE>

Figs 1–9

TYPE MATERIAL. Holotype: ♂, **Japan**: Fukui Prefecture, Ôno City, Hôkyôji, Mt. Hekosan, alt. 1100 m, 30.IX 2019, leg. S. Inoue [CHUJ].

DESCRIPTION. Dorsal surface (Fig. 1) black and shiny, without metallic luster. Appendages dark brown.

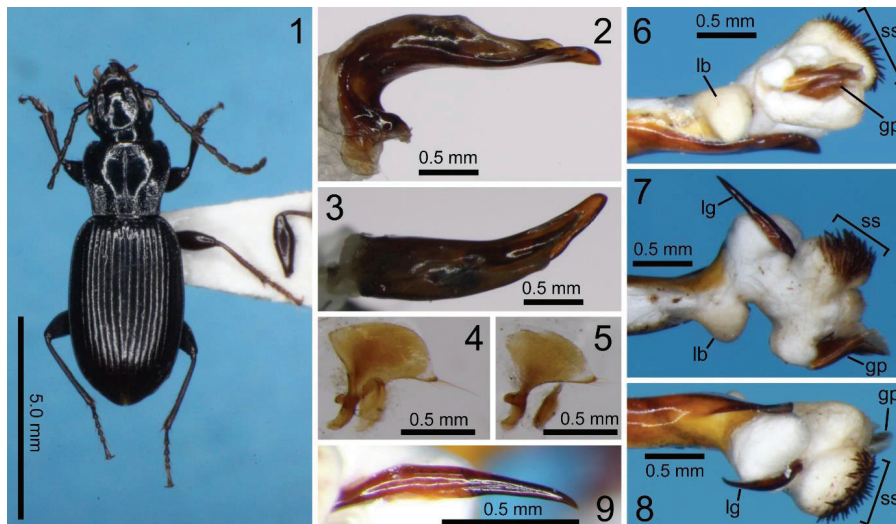
Head widest at mid-eye level; mandibles short; labrum 6-setose, with anterior margin weakly emarginate; frontal impressions large and deep, with posterior ends reaching those of the eyes; surface of frontal impressions markedly punctate; frons almost smooth; two pairs of supraorbital setae, anterior pair at mid-eye level and posterior pair at the level of the basal 1/3 of tempora; longitudinal line between eye and supraorbital seta deep and long, with posterior ends reaching apical 1/3 of tempora; eyes convex and almost the same length as tempora; tempora swollen, with the surface almost smooth; mentum tooth bifid, with a pair of setae at base; submentum with two pairs of setae. Antennae long; segments 1–2 without pubescence; one seta on segment 1; three setae on segment 2.

Pronotum quadrate, widest at apical 1/3; anterior margin weakly emarginated; posterior margin almost straight; lateral margins arcuate at apical 2/3, slightly sinuate at basal 1/3; anterior angles barely produced; posterior angles almost right-angled, with apices narrowly rounded; two pairs of marginal setae, anterior pair at apical 1/3 and posterior pair at the tip of hind angle; surface with punctations at anterior, lateral, and posterior margins and laterobasal impressions; laterobasal impression single and deep; median line deep in mid-region, but absent near anterior margin and rudimentary near posterior margins.

Elytra oblong, widest slightly behind middle; shoulders rounded, without a denticulate tooth; apices narrowly rounded, but not denticulate; intervals almost flat; scutellar stria present, but not connected to stria 1; one dorsal pore at the anterior end of stria 1; three dorsal pores on interval 3, the anterior two adjoining stria 3 and the posterior one adjoining neither stria 2 nor stria 3; hind wings atrophied.

Ventral side with punctations at neck base, prosternum, episternum, and lateral sides of sternum 2; sternum 7 with a pair of setae in holotype male. Legs stout; hind tarsomeres with two to three setae on both ventrolateral margins.

Aedeagus (Figs 2, 3) stout, bent at basal 1/4, curved to right at apical 1/3; dorsal surface membranous except for apical part; apical part thick from lateral view, widely rounded from dorsal view. Right and left parameres (Figs 4, 5) almost the same shape, broad, barely protruded at their apices; right paramere slightly smaller than left paramere.



Figs 1–9. *Apatrobus hekosanus* sp. n., holotype male. 1 – habitus, dorsal view; 2 – aedeagus, left lateral view; 3 – aedeagus, dorsal view; 4 – left paramere, left lateral view; 5 – right paramere, left lateral view; 6 – endophallus, left lateral view; 7 – endophallus, dorsal view; 8 – endophallus, right lateral view; 9 – ligula, dorsal view. Abbreviations: gp – gonoporal piece; lb – left basal lobe; lg – ligula; ss – spiny sclerites.

Endophallus (Figs 6–8) short, directed left dorsolaterally; left dorsolateral surface near ostium largely swollen (left laterobasal lobe); ligula (Fig. 9) crescent, widest at basal 1/3, with apex narrowly pointed; spiny sclerites densely developed; gonoporal piece large, strongly sclerotized.

MEASUREMENTS. BLm 8.51 mm; BLl 8.25 mm; BLc 8.00 mm. PW/HW 1.29; PW/PL 1.23; PW/PA 1.37; PW/PB 1.31; PA/PB 0.95; EW/PW 1.30; EL/EW 1.63. Length along the midline of ligula on the endophallus 1.13 mm.

DIAGNOSIS. New species similar to locally adjacent species (*A. echigonus*, *A. hasemiya*, *A. iwasakii*, and *A. narukawai*) in general appearance, but distinguished from them as follows (see also Table 1): from *A. echigonus* by narrower, quadrate pronotum (PW/PL 1.26–1.30 and cordate in *A. echigonus*) and more pointed apex of ligula on the endophallus; from *A. hasemiya* by larger body (BLc 7.38–7.82 mm in *A. hasemiya*), longer and arcuate ligula (smaller and not arcuate in *A. hasemiya*), and larger and strongly sclerotized gonoporal piece (gonoporal piece small and only weakly sclerotized in *A. hasemiya*); from *A. iwasakii* by smaller body (BLc 8.25–8.40 mm in *A. iwasakii*), larger right paramere with the apex not protruded (smaller

and protruded in *A. iwasakii*), crescent and longer ligula (wedge-shaped and shorter in *A. iwasakii*), and thicker aedeagal apex; and from *A. narukawai* by smaller body (BLc 8.55–9.75 mm in *A. narukawai*), narrower, quadrate pronotum (PW/PL 1.28–1.38 and cordate in *A. narukawai*), longer ligula (<1.00 mm in *A. narukawai* vs >1.00 in *A. hekosanus*), and thicker aedeagal apex.

## DISCUSSION

Unexpectedly, *A. hekosanus* is more similar morphologically to distant species than the nearest species *P. iwasakii* (Fig. 10; Table 1). Of the five characters for which interspecies differences are recognized (four genital and one external characters), *A. hekosanus* shares only one character state with *A. iwasakii*, but four, four, and three character states with *A. echigonus*, *A. hasemiya*, and *A. narukawai*, respectively. In particular, the narrower quadrate pronotum shared by *A. hekosanus* and *A. hasemiya* is found only in these two species within *Apatrobus* (Morita, 1985); thus, this character state in the pronotum is considered apomorphic within the genus and is probably a synapomorphy uniting these two species as sister taxa.

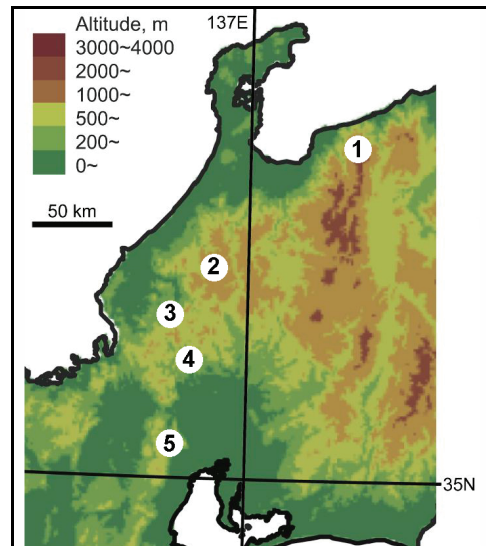


Fig. 10. Distributions of *Apatrobus* spp. in Central Honshu. 1 – *A. echigonus*; 2 – *A. hasemiya*; 3 – *A. hekosanus* sp. n.; 4 – *A. iwasakii*; 5 – *A. narukawai*.

The finding that *A. hekosanus* is probably more closely related to a more distant species, *A. hasemiya*, than to the nearest species *A. iwasakii* might be explained by speciation along an elevation gradient. *A. hekosanus* and *A. hasemiya* occur at high altitudes, whereas *A. iwasakii* occurs at low altitudes (Table 1). For *Apatrobus*, differences in elevation between nearby localities may have greater effects as geographic

barriers than differences in horizontal distance at higher elevations. This assumption is compatible with the fact that of the five species compared, only *A. iwasakii*, which occurs at low altitudes, has many peculiar morphological characters (Table 1).

Table 1. Character states of four components of the male genitalia, pronotum, and altitude of the type locality of five *Apatrobus* species.

Species	Components of male genitalia				Pronotum	Altitude of the type locality
	Aedeagal apex	Ligula	Gonoporal piece	Right paramere		
<i>A. echigonus</i>	Thick	Crescent	Large	Large	Cordate	2000 m
<i>A. hasemiya</i>	Thick	Crescent	Small	Large	Quadrangle	2400 – 2500 m
<i>A. hekusanus</i>	Thick	Crescent	Large	Large	Quadrangle	1100 m
<i>A. iwasakii</i>	Thin	Wedge-shaped	Large	Small	Cordate	330 m
<i>A. narukawai</i>	Thin	Crescent	Large	Large	Cordate	800 – 850 m*

\*According to personal communications with N. Narukawa, collector of the type material of *A. narukawai*.

In *Apatrobus*, similar, putative speciation along an elevation gradient was reported between two closely related species in Shikoku: *A. satoui* (Habu, 1976) and *A. tsurugiensis* (Habu, 1976) (Dejima & Sota, 2017). Of the two, *A. satoui* occurs at low altitudes and *A. tsurugiensis* is at high altitudes, and their distributions are geographically very close to each other. Morphological similarities and possible distributional continuity have led some authors to question the independence of these two species (e.g., Nakane, 1978). However, morphometric and molecular phylogenetic analyses have shown that *A. satoui* and *A. tsurugiensis* are clearly differentiated, which is a typical result of speciation along an elevation gradient (Dejima & Sota, 2017). The relationships among *A. hekusanus* and related species also need to be analyzed in ways similar to those performed for *A. satoui* and *A. tsurugiensis*.

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